INTERIM-FINAL
FEASIBILITY STUDY ADDENDUM

FOR THE

GULFCO MARINE MAINTENANCE
SUPERFUND SITE
FREEPORT, TEXAS

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LIST OF ACRONYMS

1,1-DCE - 1,1-dichloroethene
1,1,1-TCA – 1,1,1-trichlorothane
1,2-DCA - 1,2-dichloroethane
1,2,3-TCP - 1,2,3-trichloropropane
ARARs - Applicable or Relevant and Appropriate Requirements
AST – Aboveground Storage Tank
BaP - Benzo(a)pyrene
BERA – Baseline Ecological Risk Assessment
CERCLA – Comprehensive Environmental Response, Compensation and Liability Act
cis-1,2-DCE - cis-1,2-dichloroethene
COI – Chemicals of Interest
COPEC – Chemicals of Potential Ecological Concern
CSM – Conceptual Site Model
DDT – dichlorodiphenyltrichloroethane
EPA – United States Environmental Protection Agency
FS – Feasibility Study
gpm – gallons per minute
GRG - Gulfco Restoration Group
MBTA - Migratory Bird Treaty Act
NEDR – Nature and Extent Data Report
NPL – National Priorities List
O&M - Operation and Maintenance
PAH – Polynuclear Aromatic Hydrocarbon
PBW – Pastor, Behling & Wheeler, LLC
PCE - tetrachloroethene
PCB – Polychlorinated Biphenyl
POTW – Publically-Owned Treatment Works
PRG - Preliminary Remediation Goal
PSA - Potential Source Area
PSV – Preliminary Screening Value
PSCR - Preliminary Site Characterization Report
RAM - Remedial Alternatives Memorandum
RAO - Remedial Action Objective
RI – Remedial Investigation
RI/FS – Remedial Investigation/Feasibility Study
SLERA – Screening-Level Ecological Risk Assessment
SOW – Statement of Work
SSI – Statistically Significant Increase
TCE – trichloroethene
TCEQ – Texas Commission on Environmental Quality
TCRA - Time Critical Removal Action
TDS - Total Dissolved Solids
TNRCC – Texas Natural Resource Conservation Commission
TCE - Trichloroethene
UAO – Unilateral Administrative Order
USFWS - United States Fish and Wildlife Service
VC - vinyl chloride

EXECUTIVE SUMMARY

The United States Environmental Protection Agency (EPA) named the former site of Gulfco Marine Maintenance, Inc. in Freeport, Brazoria County, Texas (the Site) to the National Priorities List (NPL) in May 2003. The EPA issued a modified Unilateral Administrative Order (UAO), effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required Respondents to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site. The purpose of the FS is to develop a range of remedial alternatives, screen those alternatives in relation to the Remedial Action Objectives (RAOs) identified based on the conclusions of the RI, the Baseline Human Health Risk Assessment (BHHRA), and the Baseline Ecological Risk Assessment (BERA), and then perform a more detailed analysis of alternatives surviving that screening in order to identify a preferred remedial action alternative. RAOs were identified based on concerns related to future human health exposure. The RAOs are: (1) to verify, on an ongoing basis, the continued stability of the volatile organic compound (VOC) plume in Zones A and B, both in terms of lateral extent, and the absence of impacts above screening levels to underlying water-bearing units; (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway; (3) to prevent land use other than commercial/ industrial; (4) to prevent the use of groundwater at the Site; and (5) to prevent potential future exposure to residual material within the former surface impoundments.

General response actions were identified to address the above RAOs. Remedial technologies potentially applicable to those general response actions were screened and the surviving technologies were then assembled into remedial alternatives. Based on this process the following remedial alternatives were developed:

- Alternative 1 – No Action. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. This alternative serves as a baseline against which other alternatives are evaluated.

- Alternative 2 – Groundwater Controls/Monitoring. This alternative uses institutional control technologies, monitoring and an existing cap over former surface impoundments at the Site to address the RAOs. It includes the following: (1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater; (2) use of the existing former surface impoundments cap and implementation of an operation and maintenance (O&M) plan to provide for inspection/repair of the cap; (3) annual groundwater monitoring for evaluating the continued stability of the affected groundwater plume; and, as necessary, an evaluation of additional measures to address the RAOs.

- <u>Alternative 3 – Groundwater Containment.</u> This alternative uses containment technologies to address the RAOs. It includes the following: (1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater; (2) use of the existing former surface impoundments cap and implementation of an O&M plan to provide for inspection/repair of the cap; (3) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater; (4) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation; (5) discharge of treated groundwater to the City of Freeport publically-owned treatment works (POTW) or to the Intracoastal Waterway through a TPDES-permitted outfall if discharge to the POTW is not feasible; and (6) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

These three alternatives were screened against the initial criteria of short-term and long-term aspects of effectiveness, implementability, and cost. As a result of that process, all three were retained for a detailed analysis relative to the CERCLA threshold evaluation criteria of: (1) overall protection of human health and the environment; and (2) compliance with Applicable or Relevant and Appropriate Requirements (ARARs); and the CERCLA comparative evaluation criteria of : (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility, and volume through treatment; (3) short-term effectiveness; (4) implementability; and (5) cost. Per Paragraph 49 of the Statement of Work (SOW) for the RI/FS, included as an Attachment to the UAO, the comparative analysis did not consider the CERCLA modifying evaluation criteria of state acceptance and community acceptance, because the evaluation of alternatives relative to these criteria is to be performed by the EPA.

Based on a comparative analysis of the three alternatives, Alternative 2 is recommended as the preferred remedial action alternative to address the Site RAOs. Alternative 1 fails to meet the threshold criterion of overall protection of human health and the environment and thus is eliminated from further consideration. Alternatives 2 and 3 are considered roughly equivalent with regard to the criteria of: (1) overall protection of human health and the environment; (2) compliance with ARARs; and (3) reduction of toxicity, mobility, and volume through treatment. Alternative 2 is considered slightly superior to Alternative 3 with regard to the criteria of: (1) long-term effectiveness and permanence; (2) short-term effectiveness; and (3) implementability. With regard to the cost criterion, the projected present worth cost of Alternative 3 is more than 20 times greater than the projected present worth cost of Alternative 2. Thus, based on its overall superior ranking and significantly lower cost than Alternative 3, Alternative 2 is recommended as the preferred remedial action alternative for the Site.

1.0 INTRODUCTION

The EPA named the former site of Gulfco Marine Maintenance, Inc. in Freeport, Brazoria County, Texas (the Site) to the NPL in May 2003. The EPA issued a modified UAO, effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required Respondents to conduct a RI/FS for the Site. Pursuant to Paragraphs 17 through 28 of the SOW included as an Attachment to the UAO, a RI/FS Work Plan and a Sampling and Analysis Plan were prepared for the Site. These documents were approved with modifications by EPA on May 4, 2006 and were finalized on May 16, 2006. This Interim-Final Feasibility Study Report has been prepared in accordance with Paragraph 43 of the UAO, Paragraphs 43 and 46 through 50 of the SOW, and Section 5.10 of the approved RI/FS Work Plan (the Work Plan) (PBW, 2006). The Interim-Final FS Report was prepared by Pastor, Behling & Wheeler, LLC (PBW), on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow), collectively known as the Gulfco Restoration Group (GRG), and Parker Drilling Offshore Corporation, which has reached an agreement to participate in the work being performed at the Site. This addendum provides revised versions of the text and Appendix A from the Interim-Final FS Report dated June 2, 2011 based on comments provided by EPA on July 12 and 14, 2011. The tables, figures, plate, and other appendices are unchanged from the Interim-Final FS Report, except for revised versions of Tables 4 and 5, which were previously submitted to EPA on June 29, 2011. Figure 1 provides a map of the Site vicinity, while Figure 2 provides a Site map.

1.1 PURPOSE AND ORGANIZATION

As described in the SOW, the purpose of the FS is to develop a range of remedial alternatives, screen those alternatives in relation to the RAOs and the more specific Preliminary Remediation Goals (PRGs) for the Site, and perform a detailed analysis of those alternatives against CERCLA-specified evaluation criteria. A Remedial Alternatives Memorandum (RAM) (PBW, 2011a) providing the alternatives development and screening steps of that process was submitted to EPA and approved by an EPA letter dated March 22, 2011.

This FS has been organized to match the suggested FS format as provided in EPA, 1988. Site background information is provided below in Section 1.2. The identification and screening of technologies is discussed in Section 2. The development and screening of alternatives is described in Section 3. The detailed analysis of alternatives is provided in Section 4. Report conclusions are provided in Section 5. References are listed in Section 6. Consistent with SOW requirements and as specified in the Work Plan, Appendix A summarizes the chemical, location, and action-specific ARARs for each of the alternatives.

1.2 SITE BACKGROUND

1.2.1 Site Description

The Site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Figure 1). The Site consists of approximately 40 acres within the 100-year coastal floodplain along the north bank of the Intracoastal Waterway between Oyster Creek approximately one mile to the east and the Texas Highway 332 bridge approximately one mile to the west. Marlin Avenue divides the Site into two primary areas (Figure 2). For the purposes of descriptions in this report, Marlin Avenue is approximated to run due west to east. The 20-acre upland property south of Marlin Avenue (the South Area) was created from dredged material from the Intracoastal Waterway and developed for industrial uses. It contains multiple structures, a dry dock, an aboveground storage tank (AST) tank farm (which, as discussed below, has been addressed by a removal action), and two barge slips connected to the Intracoastal Waterway. The property to the north of Marlin Avenue (the North Area) contains some upland areas created from dredge spoil, but most of this area is considered wetlands, as per the United States Fish and Wildlife Service (USFWS) Wetlands Inventory Map (Figure 3). The North Area contains three adjacent closed surface impoundments and two ponds, the “Fresh Water Pond” immediately east of the impoundments, and a smaller pond to the southeast (referred to as the “Small Pond” hereafter). Site investigation activities (described below) identified a localized area of buried debris (rope, wood fragments, plastic, packing material, etc.) at depths of three feet below ground surface (bgs) immediately south of the former surface impoundments.

The South Area is zoned as “W-3, Waterfront Heavy” by the City of Freeport. This designation provides for commercial and industrial land use, primarily port, harbor, or marine-related activities. The North Area is zoned as “M-2, Heavy Manufacturing.” Restrictive covenants prohibiting any land use other than commercial/industrial and prohibiting groundwater use have been filed for all parcels within both the North and South Areas. Additional restrictions requiring any building design to preclude indoor vapor intrusion have been filed for Lots 55, 56 and 57 (see

Figure 2 for lot designations and boundaries). A further restriction requiring EPA and Texas Commission on Environmental Quality (TCEQ) notification prior to any building construction has also been filed for Lots 55, 56, and 57. Copies of the restrictive covenants for all Site parcels, including documentation confirming recording of the covenants in the Brazoria County deed records are provided in Appendix B.

Adjacent property to the north, west and east of the North Area is unused and undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west the property is currently vacant and previously served as a commercial marina. The Intracoastal Waterway bounds the Site to the south. Residential areas are located south of Marlin Avenue, approximately 300 feet west of the Site, and 1,000 feet east of the Site.

1.2.2 Site History

The Site's operating history, as constructed through historical aerial photographs, personnel interviews, operating information, investigation report summaries, and regulatory agency correspondence, inspection reports and memoranda/communication records, is discussed in detail in the Work Plan. A summary of the RI activities at the Site is provided below.

RI activities at the Site were initiated in 2006. These activities included the collection and analyses of soil, sediment, surface water, groundwater, and fish tissue samples. Results of these analyses were summarized in a Nature and Extent Data Report (NEDR) (PBW, 2009), which was approved by EPA on April 29, 2009. A summary of the NEDR findings relative to the areas addressed in this FS is provided in Section 1.2.3 below. The Final RI Report (PBW, 2011c) dated April 6, 2011 was approved by EPA on April 21, 2011.

A Final Baseline Human Health Risk Assessment (BHHRA) (PBW, 2010a) was prepared based on the data presented in the NEDR and was approved by EPA on March 5, 2010. A Final Screening-Level Ecological Risk Assessment (SLERA) (PBW, 2010b) was approved by EPA on June 9, 2010. Based on the SLERA conclusions, a Baseline Ecological Risk Assessment (BERA) was performed. Data collected for the BERA were presented in a Preliminary Site Characterization Report (PSCR) (URS, 2010c), which was approved by EPA on December 8, 2010. The Final BERA Report (URS, 2011) dated March 31, 2011 was approved by EPA on April 6, 2011.

A Time Critical Removal Action (TCRA) was performed to remove residual material in the tanks and the tanks at the AST Tank Farm. The Final Removal Action Report (PBW, 2011b), which documented the TCRA activities, included modifications requested in EPA's March 9, 2011 letter approving a draft version of that Removal Action Report.

1.2.3 Nature and Extent of Contamination

Key information pertaining to the former surface impoundments, and the nature and extent of chemicals of interest (COIs) in Site environmental media is summarized below. The nature and extent information data were previously provided in the NEDR (PBW, 2009a) and the Final RI Report (PBW, 2011c).

Former Surface Impoundments

The former surface impoundments consist of three earthen lagoons used for the storage of wash waters generated from barge cleaning operations. Covering an area of approximately 2.5 acres combined, the impoundments were reportedly three feet deep and contained a natural clay liner (TNRCC, 2000). The impoundments were closed in 1982 in accordance with a Texas Water Commission (TWC) approved plan (Carden, 1982). Closure activities were reported to include: (1) removal of liquids and most of the impoundment sludges; (2) solidification of residual sludge that was difficult to excavate; (3) and capping with three-feet of clay and a hard-wearing surface (Guevara, 1989). As shown on a topographic survey of the area (Figure 4), the impoundments cap extends approximately 1.5 to 2.5 feet above surrounding grade. The cap crown slope is about 2% with slopes of 5 to 1 (horizontal to vertical) or less at the cap edge.

The construction materials, thickness, and condition of the former surface impoundments cap were evaluated through drilling and sampling of four borings through the cap, geotechnical testing of representative cap material (clay) samples, and performance of a field inspection of the cap, including observation of desiccation cracks, erosion features, and overall surface condition. As shown in Table 1, the surface impoundment cap thicknesses at the four boring locations ranged from 2.5 feet to greater than 3.5 feet. The geotechnical properties (Atterberg Limits, and Percent Passing # 200 Sieve) of the cap material as listed in Table 1 are consistent with those recommended for industrial landfill cover systems in TCEQ Technical Guideline No. 3 (TCEQ, 2009a) and the vertical hydraulic conductivities were all better (i.e., less) than the TCEQ guideline of 1 x 10^{-7} cm/sec.

The cap field inspection was performed on August 3, 2006. The cap appeared to be in generally good condition with no significant desiccation cracks or erosion features observed on the cap surface or slopes. The cap surface consisted of a partially vegetated crushed oyster shell surface overlying the clay layer. Some sporadic indications of animal (e.g., crab) penetrations of the cap surface were observed. Occasional debris (e.g., scrap wood and telephone poles) was observed on the surface and several large bushes (approximate height of three feet) were observed, mostly near the cap edges. Drilling rig and other heavy equipment (i.e. support truck) traffic across the western end of the cap in conjunction with Site investigation activities has resulted in surface rutting of the cap in this area.

The cap investigation and inspection findings described above indicate the need for cap repair activities, specifically the restoration of a three-foot thick clay layer throughout the cap and repair of rutted areas, to meet the requirements of the aforementioned TWC-approved closure plan. These cap repair activities will be performed as part of a cap operation, maintenance, and inspection program, which will include regular inspections and repairs as necessary in the future to ensure the continued performance of the cap in accordance with the closure plan requirements. Where possible, the use of heavy equipment in marsh areas during cap repair, operation and maintenance activities will be limited to avoid causing harm to un-impacted sediment habitat. In addition, compliance with the Migratory Bird Treaty Act (MBTA) will be included as a requirement for the cap repair and other work at the Site. More specifically, grading and clearing of brush from the cap during the nesting season (usually April 1 – July 15) will be preceded by a survey conducted by a qualified biologist. The survey will investigate the vegetation growing on the cap for nests. If active nests are identified they will be avoided until the young have fledged or the nests have been abandoned.

Nature and Extent of COIs in Environmental Media

The nature and extent of COIs in Site environmental media was investigated in the RI through the installation and/or collection of 17 Site Intracoastal Waterway sediment samples, 9 background Intracoastal Waterway sediment samples, 4 Site Intracoastal Waterway surface water samples, 4 background Intracoastal Waterway surface water samples, 33 Site fish tissue samples, 36 background fish tissue samples, 190 South Area soil samples, 10 background soil samples, 41 off-site soil samples, 4 former surface impoundment cap soil borings, 29 North Area soil samples, 56 wetland sediment samples, 6 wetland surface water samples, 8 pond sediment samples, 6 pond surface water samples, 30 monitoring wells, 8 temporary piezometers, 5 permanent piezometers, and three soil borings. Most of these samples were analyzed for the list of COIs identified in the RI/FS Work Plan. Supplemental sampling of wetland sediments was performed in June 2010 and then additional samples were collected as part of BERA activities as described in Section 1.2.5 below. The nature and extent investigation locations (except for background sample locations) are plotted on Plate 1. The investigation conclusions as reported in the NEDR and Final RI Report are summarized by area/media below. The extent of COIs in these media were determined through comparisons to extent evaluation comparison criteria identified in the RI/FS Work Plan as described in the NEDR and Final RI Report. The extent evaluation comparison value for each COI in each media was the higher of the Preliminary Screening Values (PSV) listed in the Work Plan for that COI and media, as updated to reflect changes in human health or ecological toxicity values since preparation of the Work Plan, or a background value (where applicable). PSVs were the lowest of the human health-based and ecological-based criteria for a given media, using both EPA and TCEQ guidelines.

- <u>Intracoastal Waterway Sediments</u> – Certain polynuclear aromatic hydrocarbons (PAHs) (including some carcinogenic PAHs) and 4,4'-DDT were the only COIs detected in Site Intracoastal Waterway sediment samples at concentrations exceeding extent evaluation comparison values. These exceedences were limited to sample locations within or on the perimeter of the barge slip areas. Based on these data, the lateral extent of contamination in Intracoastal Waterway sediments, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to small localized areas within the two Site barge slips. A vertical extent evaluation does not apply to this medium. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- <u>Intracoastal Waterway Surface Water</u> – No COIs were detected at concentrations above their respective extent evaluation criteria in Intracoastal Waterway surface water samples collected adjacent to the Site. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- South Area Soils – COIs detected in South Area soils at concentrations exceeding extent evaluation criteria included certain metals, polychlorinated biphenyls (PCBs) and PAHs (including some carcinogenic PAHs). The lateral extent of contamination in South Area soils, as defined by COI concentrations above their respective extent evaluation criteria, was identified as limited to the South Area of the Site and potentially a small localized area immediately adjacent to the Site on off-site Lot 20 immediately to the west of the Site. A review of data (particularly lead and zinc concentrations) for the Lot 20 samples and Site samples to the east suggests the presence of an off-site contaminant source in the vicinity of a dry dock facility associated with the former commercial marina on Lot 20. As detailed in the NEDR, the sample from the 0 to 0.5 foot depth interval near the Lot 20 dry dock (sample location L20SB07 as shown on Plate 1) contained lead and zinc at concentrations of 985 mg/kg and 6,510 mg/kg, respectively. In contrast, the highest lead and zinc concentrations in samples from the same depth interval at nearby Site sample locations SA4SB18, SA5SB19, and SA6SB20 (see Plate 1) were 152 mg/kg and 414 mg/kg, respectively. In addition, the highest lead concentration in surface soil samples (0 to 1 inch depth interval) from Lot 20 locations L20SS09 and L20SS10 near the Lot 20 dry dock was 253 mg/kg, which is much lower than the aforementioned lead concentration of 985 mg/kg in the 0 to 0.5 ft depth interval sample at L20SB07. The lower surface soil (0 to 1 inch) sample concentration supports the interpretation that a contaminant source on Lot 20, rather than airborne transport of surface soil from Site areas to the east, is the source of the elevated metals concentrations observed in that area of Lot 20. The vertical extent of COIs at concentrations above extent evaluation criteria in unsaturated South Area soils was identified in the RI as limited to depths less than four feet, as no exceedences were observed in any of the RI samples from this depth. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- AST Tank Farm Soils - A localized area of visible hydrocarbon-stained soil containing some COIs at concentrations above extent evaluation criteria was observed below Tank No. 6 in the North Containment Area of the AST Tank Farm during performance of the TCRA. As detailed in the Removal Action Report, visibly impacted soil in this area extended to approximately 5.5 feet below ground surface at specific locations beneath the former location (footprint) of Tank No. 6. During the excavation of the area beneath Tank No. 6 and adjacent Tank No. 2, the subsurface material present from the ground surface to approximately 2 to 2.5 feet bgs was observed to consist of fill material (including caliche base material and clay). Outside of the Tank Nos. 2 and 6 footprints, this fill material was not visibly impacted. Except for a thin (approximately 0.2 feet thick) zone of black staining along the contact between the base of the fill and original ground surface (approximately 2 feet bgs), there was no visible staining below 2.5 feet bgs south and west of Tank No. 2. Concentrations of several VOCs [benzene, chloroform, ethylbenzene, isopropylbenzene, tetrachloroethene (PCE) and trichloroethene (TCE)] in one or more samples collected from the Tank Nos. 2 and 6 excavation area exceeded screening value comparison criteria, with concentrations ranging from less than one mg/kg to as high as 1,660 mg/kg (a complete data table is provided in the Removal Action Report). The predicted risks for these concentrations were within EPA's acceptable or target risk range for carcinogens (10^{-4} to 10^{-6} risk) and below a target hazard quotient of one for non-carcinogens, and thus no further action in this area is recommended.

- <u>North Area Soils</u> – The only COIs detected in at least one North Area soil sample at concentrations exceeding their respective extent evaluation criteria were arsenic, iron, lead, 1,2,3-trichloropropane (1,2,3-TCP), TCE, benzo(a)pyrene (BaP), dibenz(a,h)anthracene, and PCBs. The lateral extent of contamination in North Area soils, as defined by these few COI exceedences, was identified as limited to small localized areas within this part of the Site where upland soils are present (i.e., within the area surrounded by wetlands). The vertical extent of COIs at concentrations above extent evaluation criteria in North Area soils extends to the saturated zone in some locations. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- <u>Buried Debris Area</u> **-** Within the extent of North Area soil contamination, a small localized area of buried debris (rope, wood fragments, plastic, packing material, etc.) was encountered at depths of three feet bgs or more in the subsurface (below overlying clay soils) south of the former surface impoundments. Soil samples were collected from locations NE3MW05, SB-204, SB-205, and SB-206 (Plate 1) within this area. The projected extent of the buried debris area was estimated based on data from these locations and a June 1974 aerial photograph in which what appears to be the area is visible (Appendix C). Multiple samples were collected from these borings with sample depths for laboratory analyses generally corresponding to one foot depth intervals immediately above observed debris, immediately below the debris, and within the approximate center of the observed debris layer. The laboratory was unable to analyze the 3- to 4-foot depth interval sample (the debris interval sample) at boring location SB-205 for organic analytes due to solidification of the sample extracts during the concentration step of the analyses. Such solidification is consistent with olfactory and visual indications of naphthalene in this sample at the time of collection. Naphthalene concentrations in nearby SB-204 and SB-206 samples did not exceed extent evaluation comparison values. Based on these data and the lack of visual and olfactory indications of naphthalene observed during the drilling of those borings, the area containing naphthalene in buried debris or adjacent soils appears limited to the vicinity of SB-205. As detailed in the Final RI Report, concentrations of several COIs (Arochlor-1254, arsenic, iron and lead) in debris area samples exceeded extent evaluation comparison values, with concentrations ranging from 6.35 mg/kg (Arochlor-1254) to 128,000 mg/kg (iron). The predicted risks for these concentrations were within EPA's acceptable or target risk range for carcinogens (10^{-4} to 10^{-6} risk) and below a target hazard quotient of one for non-carcinogens. Based on this information, and given the depth of the debris relative to the ground surface (at least three feet bgs), and the limited and stable nature of groundwater impacts in this area (see groundwater discussion below), no further action in this area is recommended.

- <u>Wetland Sediments</u> – COIs detected in at least one wetland sediment sample at concentrations exceeding their respective extent evaluation criteria included certain metals, pesticides and PAHs (including some carcinogenic PAHs). The lateral extent of contamination in wetland sediments, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to specific areas within the Site boundaries and small localized areas immediately north and east of the Site. The vertical extent of COIs at concentrations above extent evaluation criteria in wetland sediments was identified as limited to the upper one foot of unsaturated sediment. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- <u>Wetland Surface Water</u> – Acrolein, copper, mercury, and manganese were the only COIs detected in at least one wetland surface water sample at concentrations exceeding their respective extent evaluation comparison values. The lateral extent of contamination in wetland surface water, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to localized areas within and immediately north of the Site. A vertical extent evaluation does not apply to this medium. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- Ponds Sediment – Zinc and 4,4'-DDT were the only COIs detected in at least one pond sediment sample at concentrations exceeding their respective extent evaluation comparison values. These exceedences were all limited to the "Small Pond" at the Site, which effectively defined the extent of contamination in pond sediments. A vertical extent evaluation does not apply to this medium. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- Ponds Surface Water – Arsenic, manganese, silver and thallium were the only COIs detected in at least one pond surface water sample at concentrations exceeding their respective extent evaluation comparison values. The lateral extent of pond surface water contamination, as defined by these exceedences, is limited to the extent of the two ponds. A vertical extent evaluation does not apply to this medium. The human health and ecological risk assessments concluded that there were no unacceptable risks associated with COIs in this medium.

- Groundwater – The uppermost water-bearing unit at the Site, Zone A, is generally encountered at an average depth of approximately 10 feet bgs and has an average thickness of approximately 8 feet. Saturated conditions were encountered at depths as shallow as several feet in some borings near the former surface impoundments and in other areas of the Site. Although some semivolatile organic compounds (SVOCs) and metals were detected in Zone A groundwater at concentrations exceeding extent evaluation comparison values, VOCs, particularly chlorinated solvents, their degradation products, and benzene, were the predominant COIs detected in Zone A groundwater samples. The highest COI concentrations in Zone A groundwater were generally observed in wells ND3MW02 and ND3MW29, where visible Non-Aqueous Phase Liquid (NAPL) was observed in soil cores from the base of Zone A. Concentrations of several

COIs, most notably 1,1,1-trichloroethane (1,1,1-TCA), tetrachloroethene (PCE), and TCE exceeded 1% of the compound's solubility limit, which is often used as an indicator for the possible presence of NAPL. Thus the groundwater data from these wells are consistent with the observation of visible NAPL within the soil matrix. The extent of VOCs exceeding extent evaluation comparison values and Dense Non-Aqueous Phase Liquid (DNAPL) was generally limited to a localized area within the North Area, roughly over the southern half of the former surface impoundments area and a similarly sized area immediately to the south of the former surface impoundments (Figure 5). The next underlying water-bearing unit, Zone B, is generally encountered at an average depth of approximately 19 feet bgs and has an average thickness of approximately 11 feet. The lateral extent of contamination in this zone was limited to VOCs detected in a single well (NE3MW30B) located south of the former surface impoundments. Concentrations of several COIs, most notably 1,1,1-TCA, PCE, and TCE, in NE3MW30B exceeded 1% of the compound solubility limit. These concentrations are consistent with the observation of visible NAPL within the soil matrix at the base of Zone B in the soil core from the boring at this location. The vertical extent of contamination in groundwater is limited to Zones A and B. Groundwater sampling locations in Zone B and underlying Zone C are shown on Figure 6. Groundwater was not evaluated for ecological risks as there are no ecological exposures to this medium. The human health risk assessment concluded that there were no unacceptable risks associated with groundwater-related pathways except for future exposure to an indoor industrial worker if a building is constructed over impacted groundwater in the North Area.

- Fish Tissue - In order to evaluate potential risks from ingesting recreationally caught fish from the Intracoastal Waterway, fish tissue samples were collected from four Site zones and one background area within the Intracoastal Waterway. Samples of red drum, spotted seatrout, southern flounder, and blue crab were analyzed for COIs selected based on Intracoastal Waterway sediment data. Hazard indices calculated based on the fish tissue data were several orders of magnitude below one, indicating that the fish ingestion pathway does not present an unacceptable noncarcinogenic health risk. Cancer risk estimates based on these data were 2×10^{-6} or less and thus within or below EPA's target risk range, indicating that adverse carcinogenic health effects are unlikely. Based on that evaluation, it was concluded that exposure to site-related COIs via the fish ingestion pathway does not pose a health threat to recreational anglers fishing at the Site, or their families.

1.2.4 Contaminant Fate and Transport

Potential routes of migration for Site contaminants occur in the primary transport media of air, surface water/sediment (including runoff during storm events), and groundwater. Contaminant migration routes in these media are often interrelated. The physical and chemical characteristics of COIs and their potential transport media affect the degree of contaminant persistence and rate of migration within that media. A detailed contaminant fate and transport discussion is provided in the Final RI Report (PBW, 2011c). Key considerations from that discussion are highlighted below.

Potential Air Transport Pathways

Potential airborne contaminants at the Site consist predominantly of particles, as volatile COIs were generally not detected above screening levels in near surface (1 to 2 foot depth interval) soil samples (as specified in the Work Plan, surface soil samples were not analyzed for VOCs) and generally would not be expected to persist in surface soils. Thus potential contaminant transport via air is predominantly in the solid phase. In general, only fine-grained particles are susceptible to transport in air. COIs associated with the scrap metal present in surface fill soils in the South Area and some parts of the North Area would generally not be transported via the air pathway due to the size and density of these materials. Similarly, the predominantly vegetated and moist surface soils/sediments in the North Area are not generally conducive to dust generation and particle transport. The predominant wind direction in the region is from the southeast and south (TCEQ, 2009b). Thus, potential contaminant migration via the air transport pathway would generally be toward the north and northwest from Site Potential Source Areas (PSAs). Surface samples in the North Area generally downwind from the South Area PSAs most likely to contribute metals to surface particles, such as the sand blasting areas, did not indicate elevated concentrations of metals above extent evaluation levels, and thus airborne transport from these areas appears limited. Similarly lead concentrations in surface soil samples collected on Lots 19 and 20 directly west of the Site were relatively low and not indicative of significant air transport of contaminants from Site PSAs via entrainment and subsequent deposition of particles.

Potential Surface Water/Sediment Transport Pathways

The primary surface water/sediment pathways for potential contaminant migration from Site historical PSAs are: (1) erosion/overland flow to wetland areas north and east of the Site from the North Area due to rainfall runoff and storm/tide surge; and (2) erosion/overland flow to the Intracoastal Waterway from the South Area as a result of rainfall runoff and extreme storm surge/tidal flooding events. The low topographic slope of the Site and adjacent areas is not conducive to high runoff velocities or high sediment loads. Consequently, surface soil particles would not be readily transported in the solid phase. Additionally, the vegetative cover in the North Area serves to minimize soil erosion and resulting sediment load transport with surface water in these areas. Dissolved loads associated with surface runoff from the North Area would likewise be expected to be minimal due to the absence of exposed PSAs, generally low COI concentrations in North Area surface soils/sediments, and the relatively low solubilities of those COIs (primarily pesticides, PAHs, and/or metals) that are present. Within the South Area, some PSAs, such as the sand blasting area, are exposed and COIs are present above extent evaluation levels at the ground surface. Exposed soils (primarily fill material) and indications of surface soil erosion are present within this area. Local areas of soil erosion and subsequent sediment deposition are apparent at the northern ends of the barge slips in Lots 21 and 22. The inference of surface soil erosion into the ends of the barge slips is supported by similar PAHs in sediment samples from the end of the barge slips and in nearby surface soil samples; however, the general absence of PAHs or other COIs in other areas of the barge slips toward the Intracoastal Waterway or within the waterway itself, suggests limited migration of COI-containing sediments.

Groundwater Transport Pathways

The groundwater pathway for potential transport of groundwater COIs is lateral migration within Zones A and B and vertical migration from Zone A to Zone B in areas where the clay separating Zone A and Zone B pinches out or is of minimal thickness. Vertical migration to deeper water-bearing zones below Zone B is effectively precluded by the thick (greater than 25 feet) and low vertical hydraulic conductivity (7×10^{-9} cm/sec) clay below Zone B.

Evaluations of the groundwater contaminant plume stability, the presence of potential contaminant biodegradation daughter products, and geochemical conditions favorable to biodegradation are described in the Final RI Report. These evaluations provide multiple lines of evidence for natural biodegradation of groundwater COIs and potential for limited future migration. The net overarching effect of fate and transport processes within the context of overall groundwater movement rates and directions can be assessed by considering the extent of observed contaminant migration relative to the timeframe over which that migration may have occurred. In the case of the Gulfco site, such an assessment is made through examination of the lateral extent of the primary groundwater COIs in Zone A relative to the operational period of the associated PSA, the former surface impoundments.

Barge cleaning operations at the Site began in 1971. The impoundments are visible in the 1974 aerial photograph in Appendix C. The impoundments were closed in 1982. Thus, contaminants introduced into the impoundments through barge wash waters and associated sludges have had the potential to migrate in groundwater for at least as long as 27 years (1982 to 2009) and potentially as long as 38 years (1971 to 2009). As shown on Figure 5, the lateral extent of contaminants in Zone A is generally limited to an area of approximately 200 ft or less (and in many cases, much less) from the boundary of the former surface impoundments. Dividing this distance by the potential migration period estimates of 27 to 38 years would correspond to contaminant migration rates of approximately 5 ft/year to 7 ft/year, which are consistent with both the low estimated velocity of groundwater in Zone A (discussed in the Final RI Report) and further reductions in contaminant migration due to natural biodegradation. The limited extent of contaminant migration, low groundwater velocity and demonstrated contaminant degradation also predict limited potential for future migration, as is further supported by the general stability of the dissolved COI plumes.

1.2.5 Risk Assessment

Risk assessment provides a context for evaluating the significance of site contaminants, and is used to support risk management decisions for a site. Below are the summaries of the risk assessment activities for this Site. Human health and ecological receptors were considered in these evaluations under baseline conditions (i.e., prior to any remediation at the Site).

Human Health Risk Assessment

The Final BHHRA (PBW, 2010a) was submitted to EPA on March 31, 2010. The BHHRA used data collected during the RI to evaluate the completeness and potential significance of potential human health exposure pathways indentified in the Conceptual Site Model (CSM) first presented in the Work Plan. These pathways, as updated and presented in the BHHRA, are shown for the South Area in Figure 7 and for the North Area in Figure 8. The BHHRA evaluated the potential significance of the complete human health exposure pathways indicated in these figures and concluded that there were not unacceptable cancer risks or non-cancer hazard indices for any of the five current or future exposure scenarios except for future exposure to an indoor industrial worker if a building is constructed over impacted groundwater in the North Area.

Ecological Risk Assessment

The Final SLERA (PBW, 2010b) used data collected during the RI and was submitted to EPA on May 3, 2010. The SLERA concluded that it was necessary to proceed to the next phase of EPA's ecological risk assessment process by completing a BERA. The BERA addresses the potential for adverse ecological effects to the chemicals of potential ecological concern (COPECs) and receptors identified in the SLERA through a site-specific assessment. The necessity to move the ecological risk process into a site-specific BERA was based on exceedences of protective ecological benchmarks for direct contact toxicity to invertebrates in the sediment in the wetlands and Intracoastal Waterway, soil in the North Area, and surface water in the wetlands as described in the SLERA. No literature-based food chain hazard quotients (HQs) exceeded unity (1) in the SLERA and, as such, adverse risks to higher trophic level receptors are unlikely and were not evaluated further through the BERA process.

Based on the SLERA conclusions and per the study outlined in the BERA Work Plan & Sampling and Analysis Plan (BERA WP/SAP) (URS, 2010b), the BERA included analytical chemistry analysis and toxicity testing of soil, sediment, and surface water samples corresponding to a gradient of COPEC concentrations. Several Site areas discussed in this FS were not included in the BERA, as explained in the Final BERA Problem Formulation (URS, 2010a) and Final BERA WP/SAP. As noted in Section 7.0 of the Final BERA Problem Formulation, these areas include: (1) the AST Tank Farm, where a TCRA has now been preformed; (2) the former surface impoundments cap, where cap repair activities will be performed as part of the operation and maintenance program described in Section 1.2.3 above; and (3) South Area soils, where the nature of the disturbed habitat and past, current and anticipated future land use (including the restrictive covenants for only commercial/industrial land use) obviated the need for consideration of soil exposure pathways in this area in the BERA.

Figures 9 and 10 show the relevant pathways and receptors of potential concern that were evaluated in the BERA. The BERA data, as first presented in the PSCR (URS, 2010c), indicate the following:

- The testing of *Neanthes arenaceodentata* showed no statistically significant differences between the North Area soil samples and the reference samples.
- Toxicity testing of wetland sediment using *Neanthes arenaceodentata* and *Leptocheirus plumulosus* showed no statistically significant differences between the Site wetland sediment samples and the reference wetland samples for either the growth or mortality endpoints.
- The toxicity testing of wetland surface water using *Artemia salina* showed no consistent mortality trends.
- Toxicity testing of Intracoastal Waterway sediment using *Neanthes arenaceodentata* and *Leptocheirus plumulosus* showed no statistically significant differences between the Site Intracoastal Waterway sediment samples and the Intracoastal Waterway reference samples for either the growth or mortality endpoints.
- There were no observable trends between concentration, benchmark exceedences, and observed toxicity.

These data suggest that adverse ecological risks from direct exposure to invertebrates in the soils, sediments and surface water are unlikely. The Final BERA Report (URS, 2011) documenting the above conclusions was approved by EPA on April 6, 2011.

2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLGIES

2.1 INTRODUCTION

As described in EPA guidance (EPA, 1988) the remedial alternatives development and screening process consists of the following six general steps:

- Development of remedial action objectives;
- Development of general response actions;
- Identification of volumes or areas to which the general response actions might be applied;
- Identification and screening of technologies applicable to each general response action;
- Identification and evaluation of technology process options to select a representative process for each technology type; and
- Assembly of representative technologies into alternatives.

Sections 2.2 through 2.4 below describe how the first five steps of this process are used to select remedial technologies for consideration at the Site. The assembly of these technologies into remedial alternatives in the sixth step is described in Section 3.1.

2.2 REMEDIAL ACTION OBJECTIVES

RAOs consist of medium-specific goals for protecting human health and the environment. As such, RAOs are developed for those exposure pathways identified as posing an unacceptable risk to either: (1) human receptors as described in the BHHRA; and/or (2) ecological receptors based on data developed in the BERA. As noted previously, the Final BERA Report (URS, 2011) was approved by EPA on April 6, 2011. Based on data presented in the approved PSCR and the approved Final BERA Report, no RAOs were developed based on ecological endpoints given the lack of potential risk to these receptors. As such, RAOs for the Site were identified to address concerns related to future human health exposure associated with North Area groundwater and the former surface impoundments.

The NEDR, Final BHHRA and Final RI Report note that groundwater in affected water-bearing units at the Site (Zones A and B) and the next underlying water-bearing unit (Zone C) is not useable as a drinking water source due to naturally high total dissolved solids (TDS) concentrations. Consequently, the only potentially unacceptable human health risks associated with COIs detected in Site groundwater are for the pathway involving volatilization of VOCs from North Area groundwater to a hypothetical indoor air receptor. This conclusion is based on the continued stability of the current COI plume, both in terms of lateral extent in Zones A and B and the absence of COIs in deeper water-bearing units. Restrictive covenants currently in place for Lots 55 through 57 (shown on Figure 2), which encompass the area of the VOC plume (as shown on Figure 5), require EPA and TCEQ notification and approval prior to construction of any buildings on these parcels. The covenants (included as Appendix B to this report) also advise that response actions, such as protection against indoor vapor intrusion, may be necessary prior to building construction. Thus, the RAOs for the Site are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent and absence of impacts above screening levels to underlying water bearing units; (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway; (3) to prevent land use other than commercial/industrial; (4) to prevent the use of groundwater at the Site; and (5) to prevent potential future exposure to residual material within the former surface impoundments.

As described in the SLERA (PBW, 2010b), there are no currently complete exposure pathways for ecological receptors to contact COIs in groundwater and, as such, this RAO was developed to be protective of potential future exposure to human receptors. Numeric PRGs were not calculated for this pathway since the deed restrictions will effectively prevent future exposure.

2.3 GENERAL RESPONSE ACTIONS

While RAOs are generally focused on specific potential exposure pathways, media and/or contaminant levels, general response actions describe the types of actions to be taken to satisfy the identified RAOs. As described in EPA guidance (EPA, 1988), general response actions may include treatment, containment, excavation, extraction, disposal, institutional controls, or a combination of those. General response actions, along with preliminary estimates of the area/volumes to be addressed by those response actions (as applicable) are described below.

The RAOs for the Site are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent and absence of impacts above screening levels to underlying water bearing units; (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway; (3) to prevent land use other than commercial/industrial; (4) to prevent the use of groundwater at the Site; and (5) to prevent potential future exposure to residual material within the former surface impoundments. The general response actions to address these RAOs are:

- Monitoring/Institutional Controls;
- Containment; and
- In-situ Treatment.

A monitoring/institutional controls response action would include ongoing groundwater monitoring to demonstrate continued plume stability, and modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater. Continued evaluation of the currently observed natural biodegradation of COIs in Site groundwater is an inherent part of the monitoring component of this alternative. A containment response action could entail either construction of a physical barrier, such as a slurry wall to contain affected groundwater or a groundwater collection and treatment system to provide hydraulic containment. An in-situ treatment response action would involve injection of reagents to facilitate biological or chemical treatment of the VOCs such that concentrations were reduced to levels protective of the potential groundwater to indoor air pathway and potential future migration. The identification and screening of potential technologies for these general response actions is performed in Section 2.4. The general extent of groundwater contamination as indicated by VOC concentrations in Zone A exceeding their respective extent evaluation comparison values is shown on Figure 5. VOC isoconcentration maps providing the basis of the extent area shown in this figure are provided in the NEDR. Additional explanation of these data is provided in the Final RI Report (PBW, 2011c).

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Prior to developing remedial alternatives for the general response actions described in Section 2.3, it is necessary to identify potentially applicable remedial technologies for each area/medium and screen the technologies to select only those processes that would be potentially effective at meeting the RAOs and are implementable. In the sections below, potentially applicable remedial technologies and process options are identified for the general response actions and are screened in accordance with procedures in EPA guidance (EPA, 1988). The following screening criteria were applied to each technology/process option to determine if the technology was applicable to the specific general response action being considered, and thus worthy of more detailed analysis:

- Effectiveness
  - Potential effectiveness in meeting RAOs
  - Potential impacts to human health and the environment
  - Reliability/applicability to Site COIs and conditions

- Implementability
  - Technical/administrative feasibility of implementing the technology

- Cost
  - Capital/O&M costs relative to other technologies (i.e., low, moderate, high, etc.)

The general response actions are:

- Monitoring/Institutional Controls;
- Containment; and
- In-situ Treatment.

Table 2 presents the technologies considered for these general response actions and summarizes the screening process by which these technologies were evaluated. Two monitoring/institutional control technologies (restrictive covenants and groundwater monitoring) were included in this evaluation. Both of these were retained for further evaluation and use in developing remedial alternatives.

Four physical containment technologies were screened in Table 2. These included two slurry wall technologies, sheet piling, and permeable reaction walls (designed to let groundwater pass but contain contaminants). Due to very high costs and concerns over potential adverse impacts to large areas of Site wetlands during construction, none of these technologies were retained for further evaluation.

Containment by hydraulic control was considered through the screening of four technologies, groundwater extraction via vertical wells and three subsurface drain technologies (conventional interceptor trenches, single pass trenching drains, and horizontal wells). Due to high costs, and/or low implementability for the subsurface drain technologies, the vertical extraction well option was retained as the hydraulic control technology for further evaluation and use in developing remedial alternatives.

Twelve treatment technologies, including two biological process options, nine physical/chemical process options, and one thermal process option, were considered for management of collected groundwater. As noted in Table 2, many of these technologies were characterized by low effectiveness, relatively lower implementability, and/or moderate to high costs. As a result of this screening, low profile aeration was retained as the aqueous phase treatment technology for further evaluation and use in developing remedial alternatives. Similarly, catalytic oxidation was retained as the vapor phase treatment technology for further evaluation and use in developing remedial alternatives.

Three post-treatment discharge options were considered: on-site discharge through injection wells, off-site discharge to the City of Freeport POTW, and direct discharge to the Intracoastal Waterway. As detailed in Table 2, the POTW discharge was a surviving option from this screening. Discharge to the Intracoastal Waterway was also retained as an alternative discharge option in case discharge to the POTW should prove not feasible for some reason.

In-situ treatment technologies were evaluated through biological and chemical treatment options. Natural biodegradation of COIs in Site groundwater was retained as part of all remedial alternatives. Due to low effectiveness and low implementability, neither of the other two in-situ technologies was retained for further evaluation.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Consistent with the remedial alternatives development and screening process described in EPA guidance (EPA, 1988) and summarized previously in Section 2.1 of this FS, the sixth (and final step) of the process is the assembly of representative technologies retained from the screening evaluation into remedial alternatives. This step is described in Section 3.1, below. Section 3.2 provides a screening evaluation of these alternatives for effectiveness, implementability, and cost as recommended in EPA guidance (EPA, 1988). A detailed analysis of these alternatives against the CERCLA evaluation criteria is presented in Section 4 below.

3.1 DEVELOPMENT OF ALTERNATIVES

Table 3 illustrates how surviving technology options for affected groundwater were assembled into three Site-wide remedial alternatives. Brief descriptions of each of these alternatives are provided below:

- <u>Alternative 1 – No Action.</u> Consideration of a no action alternative is specified in EPA guidance (EPA, 1988). This alternative serves as a baseline against which other alternatives are evaluated. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. This alternative effectively represents the baseline conditions evaluated in the BERA and BHHRA.

- <u>Alternative 2 – Groundwater Controls/Monitoring.</u> This alternative uses institutional control technologies, monitoring and the existing former surface impoundments cap to address RAOs for the Site. It includes the following: (1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater; (2) use of the existing former surface impoundments cap and implementation of an O&M plan to provide for inspection/repair of the cap; (3) annual groundwater monitoring for evaluating the continued stability of the affected groundwater plume; and, as necessary, an evaluation of additional measures to address the RAOs. It should be noted that the current restrictive covenants described in Item 1 above are included in Appendix B herein.

- Alternative 3 – Groundwater Containment. This alternative uses containment technologies to addresses RAOs for the Site. It includes the following: (1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater; (2) use of the existing former surface impoundments cap and implementation of an O&M plan to provide for inspection/repair of the cap; (3) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater; (4) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation; (5) discharge of treated groundwater to the City of Freeport POTW or to the Intracoastal Waterway through a TPDES-permitted outfall if discharge to the POTW is not feasible; and (6) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

3.2 SCREENING OF ALTERNATIVES

3.2.1 Introduction

As described in EPA guidance (EPA, 1988), remedial alternatives are developed to meet the identified RAOs for each area/medium of interest. During screening, the assembled alternatives are evaluated to ensure that they protect human health and the environment from each potential pathway of concern at the Site. Thus for the alternative screening, the assembled alternatives are evaluated against short-term and long-term aspects of effectiveness, implementability, and cost. These criteria are defined in the EPA guidance (EPA, 1988) for alternatives screening as follows:

- Effectiveness - This criterion pertains to the effectiveness of each alternative in protecting human health and the environment and the reductions in toxicity, mobility and volume that it will achieve. Short-term effectiveness is evaluated relative to the alternative construction and implementation period. Long-term effectiveness is evaluated relative to the period after the remedial action is complete. Reduction of toxicity, mobility, or volume refers to changes in contaminant or contaminated media characteristics by the use of treatment that decreases inherent risks or threats.

- Implementability – This criterion pertains to the technical and administrative feasibility of constructing, operating, and maintaining each alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific requirements until a remedial action is complete. It also includes the operation, maintenance, replacement, and monitoring, or technical components of alternatives into the future after the remedial action is complete (as applicable). Administrative feasibility includes both the ability to obtain any necessary approvals from regulatory agencies and the availability of treatment, storage, and disposal services and capacity.

- Cost – Both capital and O&M costs are considered for this criterion. Cost evaluation is performed on a present worth basis to evaluate expenditures that occur over different time periods.

3.2.2 Alternative 1 – No Action

The no action alternative is not effective at providing additional protection of human health and the environment with regard to the identified RAOs in either the short- or long-term. This alternative may achieve some reductions in COI toxicity, mobility and volume due to natural biodegradation; however, verification of those reductions through groundwater monitoring is not included in this alternative. Since the alternative entails no action, it is readily implemented and has no associated capital or operation and maintenance (O&M) costs. CERCLA requires evaluation of a no action alternative, so Alternative 1 is retained for detailed analysis in Section 4.

3.2.3 Alternative 2 – Groundwater Controls/Monitoring

Alternative 2 addresses the RAOs of verifying continued VOC plume stability, maintaining protection against potential VOC exposures via the groundwater to indoor air pathway, preventing land use other than commercial/industrial, preventing groundwater use through the restrictive covenants and groundwater monitoring program described previously, and preventing potential future exposure to residual material within the former surface impoundments. These alternative components are effective in protecting human health and the environment in accordance with the RAOs. This alternative may achieve some reductions in COI toxicity, mobility and volume over time due to natural biodegradation processes. An evaluation of those reductions is provided through the groundwater monitoring component of this alternative.

All components of Alternative 2 are readily implemented. Institutional controls, O&M plans and monitoring programs are all commonly used technologies that are very feasible from both technical and administrative perspectives. As noted previously, the existing cap is currently in-place.

A preliminary cost evaluation of Alternative 2 is provided in Table 4. Key assumptions regarding monitoring program requirements are listed in this table. The preliminary total present worth cost, including contingencies, for this alternative is projected at $230,000.

This preliminary screening determined that Alternative 2 is effective, implementable and of estimable cost. Thus Alternative 2 is retained for a more detailed analysis in Section 4.

3.2.4 Alternative 3 – Groundwater Containment

Alternative 3 addresses the RAOs of verifying continued VOC plume stability, maintaining protection against potential VOC exposures via the groundwater to indoor air pathway, preventing land use other than commercial/industrial, preventing groundwater use through the restrictive covenants and hydraulic control of groundwater as described previously, and preventing potential future exposure to residual material within the former surface impoundments. Hydraulic control of groundwater is maintained by groundwater extraction, treatment by air stripping and discharge to the City of Freeport POTW (or discharge to the Intracoastal Waterway should discharge to the POTW prove not feasible for some reason). These alternative components are effective in protecting human health and the environment in accordance with the Site RAOs. Although some reductions in toxicity, mobility and volume of groundwater contamination through treatment are achieved by this alternative, the groundwater objective is containment and thus toxicity, mobility and volume reductions to levels obviating the need for ongoing containment are not expected. The natural biodegradation processes occurring in Site groundwater may also over time provide reductions in toxicity, mobility, and/or volume.

All components of Alternative 3 are readily implemented. Institutional controls, O&M plans, and groundwater extraction and treatment are all commonly used technologies that are very feasible from both technical and administrative perspectives. As noted previously, the existing cap is currently in place. Although not confirmed, it is reasonable to expect adequate sanitary sewer line and treatment capacity is available at the City of Freeport POTW. In-depth discussions with the City regarding capacity, pre-treatment requirements, etc. would be needed prior to further consideration of this alternative. Should those discussions indicate that POTW discharge is not feasible, then discharge to the Intracoastal Waterway through a Texas Pollutant Discharge Elimination System (TPDES) permitted outfall would be performed.

A preliminary cost evaluation of Alternative 3 is provided in Table 5. Key assumptions regarding groundwater extraction/treatment rates, and monitoring program requirements are listed in this table. For cost estimating purposes, a POTW discharge was assumed in this table. The preliminary total present worth cost, including contingencies, for this alternative is projected at $4,700,000.

This preliminary screening determined that Alternative 3 is effective, implementable and of estimable cost. Thus Alternative 3 is retained for a more detailed analysis in Section 4.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

This section presents the detailed evaluation of the three remedial action alternatives developed during the FS screening process. Each alternative is evaluated against the CERCLA evaluation criteria as described in EPA, 1988. As specified in Paragraph 49 of the SOW, this analysis does not consider the state acceptance and community acceptance evaluation criteria, which are to be assessed by the EPA. The remaining seven CERCLA evaluation criteria are defined in the EPA guidance (EPA, 1988) for detailed alternatives analysis as follows:

- Overall Protection of Human Health and the Environment - As one of two threshold criteria, this evaluation provides a final check that each alternative provides adequate protection of human health and the environment given the specific conditions at the Site. This overall protectiveness evaluation focuses on how Site risks posed through each complete and significant potential exposure pathway, as identified by the RAOs, are addressed by treatment, engineering, or institutional controls, and whether an alternative poses any unacceptable short-term or cross media impacts.

- Compliance with ARARs – As the second threshold criteria, this evaluation assesses whether each alternative complies with all of the Federal, State and local ARARs (chemical-specific, location-specific, action-specific) identified for the Site, as well as other appropriate criteria, advisories and guidances. Each alternative must achieve this criterion or justify the lack of compliance under one of the CERCLA ARAR waiver provisions.

- Long-Term Effectiveness and Permanence - This criterion pertains to the effectiveness and permanence of each alternative in maintaining protection of human health and the environment after the RAOs have been met. This criterion also considers the following:
    - What type and degree of long-term management is required?
    - What are the requirements for long-term monitoring?
    - What operation and maintenance functions must be performed and what are the associated difficulties and uncertainties of these functions?

- What is the magnitude of the risks should the remedial alternative fail?
- What is the degree of confidence that controls can adequately handle potential problems?
- Does the alternative impact habitat?
- Will habitats resulting from remediation be of higher quality on average than existing habitats?

- Reduction of Toxicity, Mobility and Volume through Treatment – This criterion assesses the degree to which an alternative employs recycling or treatment that reduces the toxicity, mobility, and volume of waste and the anticipated performance of the recycling or treatment process. More specifically, this evaluation considers:
  - To what extent is the total mass of toxic contaminants reduced?
  - To what extent is the mobility of toxic contaminants reduced?
  - To what extent is the volume of toxic contaminants reduced?

- Short-Term Effectiveness – This criterion assesses the effectiveness of an alternative in protecting human health and the environment during the construction and implementation phase of the remedial action until the RAOs have been achieved. This evaluation focuses on on-site workers and the community and considers the following:
  - What are the risks to the community during remedial actions that must be addressed?
  - How will the risks to the community be addressed and mitigated?
  - What risks remain to the community that cannot be readily controlled?
  - What are the risks to on-site workers that must be addressed?
  - What risks remain to on-site workers that cannot be readily controlled?
  - How will the risks to on-site workers be addressed and mitigated?
  - What environmental impacts are expected with the construction and implementation of the alternative?
  - What are the available mitigation measures to be used and what is their reliability to minimize potential impacts?
  - What are the impacts that cannot be avoided should the alternative be implemented?
  - How long until protection against the threats being addressed by the specific action is achieved?

- How long until any remaining site threats will be addressed?
- How long until RAOs are achieved?

- Implementability – As for the screening evaluation described previously, this criterion assess the technical and administrative feasibility of constructing, operating, and maintaining each alternative. Specific considerations for this evaluation include:
    - What difficulties and uncertainties are associated with construction?
    - What is the likelihood that problems could lead to delays?
    - What likely future remedial actions may be anticipated and how difficult would it be to implement these, if required?
    - Do exposure pathways exist that cannot be monitored adequately and if risks of exposure exist would monitoring be insufficient to detect failure?
    - What steps are required to coordinate with other agencies?
    - Is adequate capacity available to manage any wastes generated by the remedial action?
    - Are the necessary equipment and materials available to complete the remedial action
    - Are technologies under consideration generally available and sufficiently demonstrated for the specific applications?

- Cost – As for the screening evaluation, both capital and O&M costs are considered for this criterion. The cost evaluation is performed on a present worth basis to evaluate expenditures that occur over different time periods.

Consistent with the suggested FS format in EPA, 1988, the sections below present a description and evaluation of each of the three remedial alternatives, followed by a comparative analysis of the alternatives describing the strength and weaknesses of the alternatives relative to one another.

4.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

4.2.1 Alternative 1 – No Action

4.2.1.1 Description

The no action alternative serves as a baseline against which other alternatives are evaluated. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. Thus, the current restrictive covenants would continue to be implemented under this alternative, but no other actions would be taken. As described previously, the current restrictive covenants include: (1) the prohibition of any land use other than commercial/industrial for all parcels on the Site; (2) the prohibition of any groundwater use for all parcels on the Site; and (3) the requirement that any buildings on Lots 55, 56 and 57 be designed to preclude indoor vapor intrusion and that the EPA and TCEQ be notified prior to any building construction on these parcels.

4.2.1.2 Assessment

An assessment of Alternative 1 against each of the seven criteria evaluated in this FS is provided below:

- Overall Protection of Human Health and the Environment – The current restrictive covenants on Lots 55, 56, and 57 that require future building design to preclude indoor vapor intrusion effectively make this pathway incomplete and, as such, eliminate the adverse risks identified in BHHRA; however, this alternative provides no additional protection of human health and the environment. It also does not allow for the re-evaluation/modification of the current institutional controls should the affected groundwater plume expand beyond the area of Lots 55, 56, and 57. Thus the alternative fails to adequately address the RAOs of verifying the continued stability of the affected groundwater plume, and maintaining protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway.

- Compliance with ARARs – Through the current restrictive covenants, the no action alternative complies with the chemical-specific ARARs associated with Site-specific risk levels developed in the BHHRA. Since this alternative requires no other action, there are no applicable location-specific or action-specific ARARs for which compliance is needed.

- Long-Term Effectiveness and Permanence – Alternative 1 is not effective in the long term in meeting RAOs or maintaining protection of human health and the environment. Since the alternative requires no action, it does not include any long-term management or monitoring components and does not result in any habitat impacts as part of its implementation.

- Reduction of Toxicity, Mobility and Volume through Treatment – As described previously, the currently observed natural biodegradation of COIs in Site groundwater likely provides some reductions in toxicity, mobility and volume of affected groundwater through this intrinsic in-situ treatment. No added reductions in toxicity, mobility and volume through treatment are provided by Alternative 1.

- Short-Term Effectiveness – Alternative 1 is not effective at meeting RAOs in the short term. Since the alternative requires no action, it does not present any associated risks to the community or on-site workers, nor does it results in any environmental impacts as part of its implementation.

- Implementability – Since Alternative 1 does not require any action, it is easily implemented. No technical or administrative feasibility concerns are associated with this alternative.

- Cost – Since Alternative 1 does not require any action, it does not have any associated capital or O&M costs.

4.2.2 Alternative 2 – Groundwater Controls/Monitoring

4.2.2.1 Description

Alternative 2 uses institutional controls, monitoring and the existing former surface impoundments cap to address RAOs for the Site. It includes the following:

> (1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater;
>
> (2) use of the existing former surface impoundments cap and implementation of an O&M plan to provide for inspection/repair of the cap; and
>
> (3) annual groundwater monitoring for evaluating the continued stability of the affected groundwater plume; and, as necessary, an evaluation of additional measures to address the RAOs.

As noted above modifications to the current restrictive covenants will include the addition of supplemental information regarding the affected groundwater plume, such as a metes and bounds description of the affected area and a list of the contaminants present.

For the monitoring component of this alternative, the continued stability of the affected groundwater plume will be verified by an evaluation of the temporal trends of the primary groundwater COIs [1,1,1-TCA; 1,1-dichloroethene (1,1-DCE); 1,2,3-trichloropropane (1,2,3-TCP); 1,2-dichloroethane (1,2-DCA); benzene; cis-1,2-dichloroethene (cis-1,2-DCE); methylene chloride; PCE; TCE; and vinyl chloride (VC), as described in the Final RI Report] above their respective extent evaluation criteria (as presented in the Final RI Report) in perimeter monitoring wells using a Mann-Kendall test or similar analysis. The statistical analysis shall be performed in accordance with the EPA guidance *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA, 2009). For the purposes of this evaluation, Zone A perimeter monitoring wells will include wells OMW21, NG3MW19, ND4MW03, NB4MW18, NC2MW28, and OMW20 (Figure 5). Zone B perimeter monitoring wells will include OMW27B, NG3MW25B, NE4MW31B, and ND4MW24B (Figure 6). Should such trend analysis indicate a statistically significant increase (SSI), additional sampling will be performed at the indicated location within 30 days of determination of the SSI to confirm the trend. Should a confirmed SSI be indicated, then an evaluation of possible plume expansion will be performed by the installation of one or more additional monitoring wells outward from the affected well (or wells) as necessary to bound the plume to the appropriate extent evaluation comparison values. Although not used for the temporal trend analysis and contingent evaluation of plume stability, sampling and analysis of monitoring wells NE1MW04, NF2MW06, ND3MW29, NE4MW30B, and NE4MW32C will also be performed.

4.2.2.2 Assessment

An assessment of Alternative 2 against each of the seven criteria evaluated in this FS is provided below:

- Overall Protection of Human Health and the Environment – Alternative 2 provides overall protection of human health and the environment. It addresses the RAO of verifying the continued stability of the affected groundwater plume through groundwater monitoring. It addresses the RAO of maintaining protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway by using the monitoring component to identify if any plume expansion is occurring and then provides for modification of the restrictive covenants as necessary to provide protection against potential exposures via the groundwater to indoor air vapor intrusion pathway. It addresses the RAOs of preventing land use other than commercial/industrial, and preventing use of ground water at the Site through restrictive covenants. It uses the existing former surface impoundments cap and ongoing operation and maintenance of the cap to prevent potential future exposure to residual material within the former surface impoundments.

- Compliance with ARARs – Through the restrictive covenants and groundwater monitoring program, Alternative 2 complies with the chemical-specific ARARs associated with Site-specific risk levels developed in the BHHRA. The annual groundwater sampling to be performed as part of this alternative would have minimal effects on the wetland and coastal zone habitats in which the monitoring wells are constructed, and thus the alternative complies with the location-specific ARARs associated with those areas as described in Appendix A. The only action-specific ARAR described in Appendix A that applies to Alternative 2 is related to the existing cap at the former surface impoundments. As detailed in Appendix A, the existing cap complies with this potential ARAR.

- Long-Term Effectiveness and Permanence – Alternative 2 is effective at protecting human health and the environment over the long-term. It contains a long-term groundwater monitoring component which will include maintenance of the monitoring well network. The resultant risks, if any, that might occur should the monitoring program fail to detect any plume expansion would be expected to be minor, given the limited extent of contaminant migration observed during the 27 to 38 years since operation and closure of the former surface impoundments, the low groundwater velocity at the Site and the observed natural biodegradation of the groundwater COIs. Similarly should the affected groundwater plume migrate beyond Lots 55, 56 and 57, the resultant potential risks associated with the indoor vapor intrusion pathway in areas outside of these parcels would be expected to be low due to: (1) the fact that the clayey vadose soils that overly the affected groundwater are generally not conducive to COI vapor migration; and (2) the low likelihood that any structures would actually be built in these areas given the regulatory complications associated with construction within the wetland area in which the affected groundwater plume is located. Thus, Alternative 2 would be expected to be reliable in meeting the RAOs over the long term. Potential habit impacts from the annual groundwater monitoring events and from O&M of the existing former surface impoundments cap would be expected to be minimal.

- Reduction of Toxicity, Mobility and Volume through Treatment – As described previously, the currently observed natural biodegradation of COIs in Site groundwater likely provides some reductions in toxicity, mobility and volume of affected groundwater through this intrinsic in-situ treatment. An evaluation of those reductions will be provided by the groundwater monitoring component of the alternative. No added reductions in toxicity, mobility and volume through treatment are provided by Alternative 2.

- Short-Term Effectiveness – Alternative 2 is effective at meeting RAOs and providing protection of human health and the environment in the short term. Since the primary field activities consist of monitoring and maintaining existing monitoring wells and maintaining the existing former surface impoundments cap, it does not present any appreciable associated risks to the community or on-site workers nor does it result in any environmental impacts as part of its implementation.

- Implementability – Alternative 2 is easily implemented. Since the alternative provides for monitoring of existing monitoring wells and does not require the installation of any new wells, it can be readily implemented. The former surface impoundments cap is already in-place and can be readily maintained through the O&M plan. Groundwater monitoring programs and institutional controls are commonly used and accepted remedial technologies that do not pose any significant technical or administrative feasibility concerns.

- Cost – Preliminarily projected one-time costs and annual O&M costs for Alternative 2 are listed in Table 4. As shown therein, one-time costs for this alternative include modification of institutional controls, preparation of the cap O&M plan, and plugging and abandonment of existing monitoring wells not included in the long-term groundwater monitoring program. Annual O&M costs primarily consist of sample collection and analysis, monitoring data evaluation, and well repair/maintenance (as needed). No costs are included for the existing cap since it is already in place. The present worth of these costs (assuming a 30 year period and 7% discount factor), including contingencies recommended in EPA, 2000, is $230,000.

4.2.3 Alternative 3 – Groundwater Containment

4.2.3.1 Description

Alternative 3 uses containment technologies to address RAOs for the Site. It includes the following:

(1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater;

(2) use of the existing former surface impoundments cap and implementation of an O&M plan to provide for inspection/repair of the cap;

(3) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater;

(4) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation;

(5) discharge of treated groundwater to the City of Freeport POTW or to the Intracoastal Waterway through a TPDES-permitted outfall if discharge to the POTW is not feasible; and

(6) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

For the purposes of evaluating this alternative, it is assumed that hydraulic control of the affected groundwater plume can be maintained through the installation and operation of 14 extraction wells in Zone A and 6 extraction wells in Zone B at a cumulative extraction flow rate of 40 gallons per minute (gpm). Should this alternative be selected further evaluation of those assumptions would be needed prior to system design. Under Alternative 3, extracted groundwater would be collected and conveyed to a central treatment compound located in the North Area of the Site. Here the extracted water would be pumped to a sedimentation/surge tank and then a low profile aeration (e.g., tray air stripper) treatment system for VOC removal prior to discharge to a City of Freeport sanitary sewer inlet to be located on the north side of Marlin Avenue. Based on the assumption of POTW discharge, no additional treatment would likely be needed. In the event that discharge to the POTW was not feasible and discharge to the Intracoastal Waterway was required, additional effluent treatment prior to discharge would likely be necessary. Based on concentrations of VOCs detected within the affected groundwater plume, it is assumed that off-gas from the aeration unit would require treatment through a catalytic oxidation unit (fueled by on-site propane tank). Additional details and assumptions regarding this alternative are listed in Table 5.

The effectiveness of the treatment system would require monitoring through periodic effluent sampling and analysis and air emissions testing (organic vapor meter monitoring). The alternative effectiveness in terms of plume migration control would be verified through the monitoring and statistical evaluation program described for Alternative 2 above.

4.2.3.2 Assessment

An assessment of Alternative 3 against each of the seven criteria evaluated in this FS is provided below:

- Overall Protection of Human Health and the Environment – Alternative 3 provides overall protection of human health and the environment. It addresses the RAO of verifying the continued stability of the affected groundwater plume through groundwater monitoring. It addresses the RAO of maintaining protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway by using hydraulic control to prevent plume expansion. It also contains a monitoring component to identify if any plume expansion were to occur and provides for modification of the restrictive covenants as necessary to provide protection against potential exposures via the groundwater to indoor air vapor intrusion pathway. It addresses the RAOs of preventing land use other than commercial/industrial, and preventing use of ground water at the Site through restrictive covenants. It uses the existing former surface impoundments cap and ongoing operation and maintenance of the cap to prevent potential future exposure to residual material within the former surface impoundments.

- Compliance with ARARs – Through the restrictive covenants and groundwater monitoring program, Alternative 3 complies with the chemical-specific ARARs associated with Site-specific risk levels developed in the BHHRA. The construction of groundwater extraction wells, the treatment compound and associated piping could potentially affect the wetland and coastal zone habitats in which the monitoring wells are constructed and thus care would need to be taken during the construction phase of this alternative to comply with the provisions of those locations-specific ARARs as described in Appendix A. This alternative would also need to comply with action-specific ARARs described in Appendix A. As detailed in Appendix A, the existing cap complies with a potential ARAR related to its composition.

- Long-Term Effectiveness and Permanence – Alternative 3 is effective at protecting human health and the environment over the long-term. It includes multiple long-term components, such as operation/maintenance of the groundwater extraction and treatment system, performance of groundwater monitoring, and maintenance of restrictive covenants. Any resultant risks that might occur should the groundwater extraction and treatment system fail to provide hydraulic control of the affected groundwater and the monitoring program fail to detect any plume expansion would be expected to be minor, given the limited extent of contaminant migration observed during the 27 to 38 years since operation and closure of the former surface impoundments, the low groundwater velocity at the Site and the observed natural biodegradation of the groundwater COIs. Similarly, as noted above, should the affected groundwater plume migrate beyond Lots 55, 56 and 57, the resultant potential risks associated with the indoor vapor intrusion pathway in areas outside of these parcels would be expected to be low due to: (1) the fact that the clayey vadose soils that overly the affected groundwater are generally not conducive to COI vapor migration; and (2) the low likelihood that any structures would actually be built in these areas given the regulatory complications associated with construction within the wetland area in which the affected groundwater plume is located. Installation of groundwater extraction wells and associated piping to and from the treatment compound would locally impact the wetland areas and associated habitat. Potential habit impacts from O&M of the existing former surface impoundments cap would be expected to be minimal.

- Reduction of Toxicity, Mobility and Volume through Treatment – As described previously, the currently observed natural biodegradation of COIs in Site groundwater likely provides some reductions in toxicity, mobility and volume of affected groundwater. The groundwater monitoring component of Alternative 3 will provide an evaluation of those reductions. Since the operation of the extraction and treatment system, which is focused on groundwater containment (and not treatment), Alternative 3 would not provide significant additional reductions in the toxicity, mobility, or volume of the affected groundwater, although treatment of the extracted groundwater and off-gas from the treatment system would reduce the toxicity of the extracted groundwater itself.

- Short-Term Effectiveness – Alternative 3 is effective at meeting RAOs and providing protection of human health and the environment in the short term. Potential safety risks presented to on-site workers during the construction of the groundwater extraction and treatment system would likely be similar to any construction project of like size. Installation of the extraction wells would need to be performed in accordance with OSHA HAZWOPER requirements (29 CFR 1910.120). The primary risks to the local community would be safety risks associated with a temporary increase in equipment traffic to the Site during the construction period. As noted above, some local habitat impacts would be expected in the extraction well and treatment compound areas during the construction period. Maintaining the existing former surface impoundments cap would not present any appreciable associated risks to the community or on-site workers nor would it result in any environmental impacts as part of its implementation.

- Implementability – Alternative 3 can be readily implemented. The former surface impoundments cap is already in-place and can be readily maintained through the O&M plan. The groundwater extraction and treatment components of this alternative are commonly used technologies for this type of application, with the greatest potential technical feasibility issue likely associated with the start-up of the catalytic oxidation system to be used for off-gas treatment from the air stripper. No major administrative difficulties would be anticipated, with the greatest potential administrative feasibility issue likely associated with the discharge of treated groundwater to the City of Freeport POTW, particularly if sufficient conveyance or treatment capacity is not available. As noted previously, should discharge to the POTW prove to be overly difficult, then discharge to the Intracoastal Waterway would need to be arranged. Discharge to the Intracoastal Waterway would require procurement of a TPDES discharge permit and construction of additional discharge piping below Marlin Avenue and across the South Area of the Site.

- Cost – Preliminarily projected one-time costs and annual O&M costs for Alternative 3 are listed in Table 5. As shown therein, one-time costs for this alternative, which include extraction well installation and treatment compound construction (including equipment) costs, are projected to total about $880,000. Annual O&M costs, which primarily consist of system maintenance, sampling/analysis, electricity, fuel (for the catalytic oxidation unit), and POTW discharge charges, are projected at about $250,000 per year. No costs are included for the existing cap since it is already in place. The projected present worth of these costs (assuming a 30 year period and 7% discount factor), including contingencies recommended in EPA, 2000, is $4,700,000.

4.3 COMPARATIVE ANALYSIS

The three remedial alternatives developed for this FS were individually assessed against EPA's CERCLA evaluation criteria in Section 4.2 above. Consistent with the general FS outline provided in EPA, 1988, a comparative analysis is performed below to evaluate the relative performance of each alternative in relation to each specific evaluation criteria. As noted previously for the individual alternative analyses, the comparative analysis does not consider the state acceptance and community acceptance criteria, which are to be evaluated by the EPA per Paragraph 49 of the SOW.

4.3.1 Overall Protection of Human Health and the Environment

Alternative 1 provides no additional protection of human health and the environment beyond the current restrictive covenants on Lots 55, 56, and 57 that require future building design to preclude indoor vapor intrusion. Thus Alternative 1 fails to adequately address the RAOs of verifying the continued stability of the affected groundwater plume, and maintaining protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway. In contrast, Alternatives 2 and 3 both adequately address the RAOs and provide overall protection of human health and the environment. Alternative 2 provides this protection through an ongoing groundwater monitoring program to verify that the affected groundwater plume remains stable and does not expand beyond the areas for which restrictive covenants provide protection against potential exposures via the groundwater to indoor air vapor intrusion pathway. Alternative 3 includes this groundwater monitoring program, and also uses a groundwater extraction and treatment program to provide hydraulic control as a redundant measure of protection. Thus Alternatives 2 and 3 meet this threshold criterion, but Alternative 1 does not.

4.3.2 Compliance with ARARs

Through the current restrictive covenants, all three alternatives comply with the chemical-specific ARARs associated with Site-specific risk levels developed in the BHHRA. Since Alternative 1 requires no other action, there are no applicable location-specific or action-specific ARARs for which compliance is needed. The location-specific ARARs associated with wetland and coastal zone habitats at the Site and an action-specific ARAR related to the existing former surface impoundments cap are a consideration for Alternative 2, but would not be expected to pose any significant compliance concerns or implications for this alternative. The location-specific ARARs would be a more significant consideration for Alternative 3, which would involve much more extensive construction within these areas and thus have a potential for their disruption and/or need for mitigation or restoration. Multiple action-specific ARARs could potentially apply to Alternative 3. The existing former surface impoundments cap complies with an action-specific ARAR related to its composition. The groundwater treatment and discharge components of this alternative would need to be designed to comply with other action-specific ARARs. Thus all three alternatives meet this threshold criterion, but Alternative 3 has a higher potential to present potential compliance concerns or implications than Alternatives 1 and 2.

4.3.3 Long-Term Effectiveness and Permanence

Alternative 1 provides the lowest long-term effectiveness and permanence because it is not effective in the long term in meeting RAOs or maintaining protection of human health and the environment. Alternatives 2 and 3 are effective in meeting the RAOs over the long term and provide a generally similar level of long-term effectiveness and permanence. Both would be expected to be reliable, and both have a relatively low risk associated with their potential failure. Alternatives 2 and 3 both include long-term monitoring and management components, although those long-term components are much more complex for Alternative 3. Alternative 2 would not be expected to pose any appreciable potential habitat impacts, while habitat impacts from Alternative 3 would be expected to be more significant. Taken as a whole, this analysis suggests that Alternative 2 provides the highest long-term effectiveness and permanence, Alternative 3 provides a slightly lower long-term effectiveness and permanence, and Alternative 1 does not provide long-term effectiveness and permanence.

4.3.4 Reduction of Toxicity, Mobility and Volume through Treatment

Under all three alternatives, the currently observed natural biodegradation of COIs in Site groundwater likely provides some reductions in toxicity, mobility and volume of affected groundwater through this intrinsic in-situ treatment. An evaluation of those reductions will be provided by the groundwater monitoring component of Alternatives 2 and 3. No significant added reductions in toxicity, mobility and volume of the affected groundwater plume are provided by any of the three alternatives. Treatment of the extracted groundwater and off-gas from the treatment system as part of Alternative 3 would reduce the toxicity of the extracted groundwater itself, but in terms of the affected groundwater plume, all three alternatives are considered equivalent with regard to this balancing criterion.

4.3.5 Short-Term Effectiveness

Alternative 1 provides the lowest short-term effectiveness because it is not effective in the short-term in meeting RAOs or maintaining protection of human health and the environment. Alternatives 2 and 3 are both effective at meeting RAOs and providing protection of human health and the environment in the short term. Alternative 2 does not present any associated risks to the community or on-site workers or any appreciable environmental impacts as part of its implementation. Alternative 3 would present safety risks to on-site workers similar to those inherent in any construction project, and would present slight safety risks to the local community due to the temporary increase in traffic to the Site during the construction period. Alternative 3 would probably result in some local habitat impacts in the extraction well and treatment compound areas during the construction period. Thus Alternative 2 provides the highest short-term effectiveness, Alternative 3 provides a slightly lower short-term effectiveness, and Alternative 1 is not considered effective in the short term.

4.3.6 Implementability

Since it requires no action, Alternative 1 is the most easily implemented. Alternatives 2 and 3 are both readily implemented as both utilize widely accepted and proven technologies. Alternative 2 is considered more implementable than Alternative 3 because Alternative 3 involves the technologically more complex components of treatment system construction and operation, including catalytic oxidation of air stripper off gas treatment, and the administratively more complex component of effluent discharge to a POTW or through a TPDES permit.

4.3.7 Cost

Since Alternative 1 involves no new actions, its cost is projected at $0 for the purposes of this evaluation. The projected present worth cost of Alternative 2 is $230,000 (Table 4). The projected present worth cost of Alternative 3 is $4,700,000 (Table 5).

4.3.8 Preferred Remedial Action Alternative

Based on the comparative analysis presented above, Alternative 2 is recommended as the preferred remedial action alternative to address the Site RAOs. Alternative 1 fails to meet the threshold criterion of overall protection of human health and the environment and thus is eliminated from further consideration. Alternatives 2 and 3 are considered roughly equivalent with regard to the criteria of: (1) overall protection of human health and the environment; (2) compliance with ARARs; and (3) reduction of toxicity, mobility, and volume through treatment. Alternative 2 is considered slightly superior to Alternative 3 with regard to the criteria of: (1) long-term effectiveness and permanence; (2) short-term effectiveness; and (3) implementability. The projected present worth cost of Alternative 3 is more than 20 times greater than the projected present worth cost of Alternative 2.

5.0 CONCLUSIONS

The purpose of the FS is to develop a range of remedial alternatives, screen those alternatives in relation to the RAOs and then perform a more detailed analysis of alternatives surviving that screening. RAOs were identified based on concerns related to future human health exposure associated with North Area groundwater and the former surface impoundments. The RAOs are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent, and the absence of impacts above screening levels to underlying water-bearing units; (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway; (3) to prevent land use other than commercial/ industrial; (4) to prevent the use of groundwater at the Site; and (5) to prevent potential future exposure to residual material within the former surface impoundments.

General response actions were identified to address the above RAOs. Remedial technologies potentially applicable to those general response actions were screened and the surviving technologies were then assembled into remedial alternatives. Based on this process the following remedial alternatives were developed:

- Alternative 1 – No Action. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. This alternative serves as a baseline against which other alternatives are evaluated.

- Alternative 2 – Groundwater Controls/Monitoring. This alternative uses institutional control technologies, monitoring and the existing former surface impoundments cap to address RAOs for the Site. It includes the following: (1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater; (2) use of the existing former surface impoundments cap and implementation of an O&M plan to provide for inspection/repair of the cap; (3) annual groundwater monitoring for evaluating the continued stability of the affected groundwater plume; and, as necessary, an evaluation of additional measures to address the RAOs.

- Alternative 3 – Groundwater Containment. This alternative uses containment technologies to address RAOs for the Site. It includes the following: (1) modification of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots such that the covenants identify the type and location of hazardous substances in groundwater; (2) use of the existing former surface impoundments cap and implementation of an O&M plan to provide for inspection/repair of the cap; (3) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater; (4) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation; (5) discharge of treated groundwater to the City of Freeport POTW or to the Intracoastal Waterway through a TPDES-permitted outfall if discharge to the POTW is not feasible; and (6) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

These three alternatives were screened against the initial criteria of short-term and long-term aspects of effectiveness, implementability, and cost. As a result of that process, all three were retained for a detailed analysis relative to the CERCLA threshold evaluation criteria of: (1) overall protection of human health and the environment; and (2) compliance with ARARs; and the comparative evaluation criteria of: (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility, and volume through treatment; (3) short-term effectiveness; (4) implementability; and (5) cost. Per Paragraph 49 of the SOW, the comparative analysis did not consider the modifying criteria of state acceptance and community acceptance, as the evaluation relative to these criteria is to be performed by the EPA.

Based on a comparative analysis of the three alternatives, Alternative 2 is recommended as the preferred remedial action alternative to address the Site RAOs. Alternative 1 fails to meet the threshold criterion of overall protection of human health and the environment and thus is eliminated from further consideration. Alternatives 2 and 3 are considered roughly equivalent with regard to the criteria of: (1) overall protection of human health and the environment; (2) compliance with ARARs; and (3) reduction of toxicity, mobility, and volume through treatment. Alternative 2 is considered slightly superior to Alternative 3 with regard to the criteria of: (1) long-term effectiveness and permanence; (2) short-term effectiveness; and (3) implementability.

With regard to the cost criterion, the projected present worth cost of Alternative 3 is more than 20 times greater than the projected present worth cost of Alternative 2. Thus, based on its overall superior ranking and significantly lower cost than Alternative 3, Alternative 2 is recommended as the preferred remedial action alternative for the Site.

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) EVALUATION

APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) EVALUATION

A.1 INTRODUCTION

The purpose of this appendix is to identify applicable or relevant and appropriate requirements (ARARs) with which remedial actions must comply at the Gulfco Marine Maintenance Superfund Site (the Site). Applicable requirements are federal or state requirements that "specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" (National Contingency Plan (NCP) Section 300.5). Relevant and appropriate requirements are federal or state requirements that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action or other circumstance at a CERCLA site, "address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site." (NCP Section 300.5). "To be considered" (TBC) materials include federal or state guidance, advisories, criteria, or proposed standards that may be useful in situations where no ARARs exist.

In accordance with the National Contingency Plan, remedial actions under CERCLA are required to meet the substantive requirements of other laws unless an ARAR waiver is granted by the lead regulatory agency. Compliance with the administrative requirements (e.g., permitting, administrative reviews, reporting, and recordkeeping) of other laws is not required under CERCLA. Consistent with EPA guidance (EPA, 1988), the substantive ARARs are divided into the three categories:

- **Chemical-specific requirements**– health- or risk-based numerical values or methodologies that specify the acceptable amount or concentration of a chemical that may be found in, or discharged to, the environment;

- **Location-specific requirements**– restrictions placed on the types of activities that can be conducted or on the concentration of hazardous substances that can be present solely because of the location where they will be conducted; and

- **Action-specific requirements–** technology or activity-based requirements or limitations on actions taken with respect to hazardous wastes.

A.2 CHEMICAL-SPECIFIC ARARs

RCRA waste classification requirements, specifically the RCRA hazardous waste criteria specified in 40 CFR 261 Subpart C, are chemical-specific ARARs that apply to wastes that are generated as part of Site remedial actions. These requirements, along with Texas waste classification rules provided in 30 TAC 335 Subchapter R, would be used to determine the classification (i.e., hazardous or non-hazardous Class 1, 2, or 3) for any wastes managed at an off-site treatment, storage or disposal facility.

Texas Risk Reduction Program (TRRP) Protective Concentration Levels (PCLs) specified in 30 *TAC* Chapter 350 serve as chemical-specific criteria for the investigation/remediation of the Site. These PCLs, along with other EPA-specific chemical-specific criteria, were used to define the extent of contamination at the Site as described in the Nature and Extent Data Report (NEDR) (PBW, 2009) and the Draft RI Report (PBW, 2011a). The TRRP PCLs were not used in place of the site-specific Baseline Human Health Risk Assessment (BHHRA) and Baseline Ecological Risk Assessment (BERA) to establish site-specific risk levels (and Remedial Action Objectives) for those areas of the Site that pose risk to human health or the environment.

The Gulfco Site is adjacent to the Intracoastal Waterway, and this portion of the Intracoastal Waterway is a tidal water body. A tidal water body is by definition deemed to be a sustainable fishery [30 TAC §307.3(a)(67)]. Therefore the fish-only criteria for human health as specified in the Texas Surface Water Quality Standards (TSWQS) [30 TAC §307.6(d)(2)(B)] serve as chemical-specific criteria for surface water concentrations in the Intracoastal Waterway adjacent to the Site in the event affected groundwater was to discharge to the Intracoastal Waterway.

A.3 LOCATION-SPECIFIC ARARs

Location-specific ARARs are divided into the following four sections:

A.3.1 Wetlands;
A.3.2 Critical Habitat for Endangered or Threatened Species;
A.3.3 Coastal Zones; and
A.3.4 Floodplains.

A.3.1 <u>Wetlands</u>

As described in Section 1.0, much of the North Area is considered wetlands on the USFWS Wetlands Inventory Map. Potential ARARs associated with wetlands are described in EPA's *Considering Wetlands at CERCLA Sites* (EPA, 1994a). As described therein, a primary potential ARAR related to wetlands is Section 404(b)(1) of the Clean Water Act (CWA), promulgated as regulation in 40 CFR 230.10, which generally prohibits discharge of dredged or fill material to wetlands, subject to consideration of practicable alternatives and the use of mitigation measures. Section 404 would be considered an ARAR for Site remedial actions involving excavation of wetlands areas or placement of fill into wetlands for access road construction. Per 40 CFR 6.302(a), Executive Order 11990 further requires that any actions performed within wetland areas minimize the destruction, loss, or degradation of wetlands.

A.3.2 <u>Critical Habitat for Endangered/Threatened Species</u>

The Final SLERA (PBW, 2010b) notes a number of endangered/threatened species listed as present in Brazoria County by the US Fish and Wildlife service. None of these species have been noted at the Site but they are known to live in or on, feed in or on, or migrate through the Texas Gulf Coast and estuarine wetlands. Remedial actions that impact rare, threatened, and endangered species may be subject to applicable federal and state requirements. The Fish and Wildlife Coordination Act (16 USC 661 et. seq.), the Endangered Species Act of 1973 (16 USC 1531) and subsequent regulations govern the protection of critical habitat for endangered or threatened species. These regulations include:

- 40 *CFR* §6.302(h)—USEPA Procedures for Implementing Endangered Species Protection Requirements Under the Endangered Species Act;

- 40 *CFR* §230.30—Potential Impacts on Biological Characteristics of the Aquatic Ecosystem. Threatened and endangered species;

- 50 *CFR* Part 402—Interagency Cooperation—Endangered Species Act of 1973, as Amended; and

- 31 *TAC* §501.23(a)—Texas Coastal Coordination Council Policies for Development in Critical Areas, including 31 *TAC* §501.23(a) (7) (A) relating to endangered species.

The Endangered Species Act prohibits federal agencies' programs (e.g., CERCLA) from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival. Under 40 *CFR* §6.302(h) for actions where USEPA is the lead agency, the responsible party must identify designated endangered or threatened species or their habitat that may be affected by the remedial action.

Section 230.30 pertains to potential impacts of remedial action on threatened and endangered species, such as covering or otherwise directly killing species, or destruction of habitat to which these species are limited. If listed species or their habitat may be affected by a remedial action, formal consultation with the USFWS, TPWD, and the NMFS must be undertaken, as appropriate. (50 *CFR* Part 402 provides procedures for interagency cooperation and interaction.) If the consultation reveals that the activity may jeopardize a listed species or habitat, mitigation measures need to be considered.

At the state level, 31 *TAC* §501.23(a) (7) (A) prohibits development in critical areas if the activity will jeopardize the continued existence of endangered or threatened species or will result in the destruction or adverse modification of their habitat. This section also specifies compensatory mitigation.

A.3.3 <u>Coastal Zones</u>

The Coastal Zone Management Act of 1972 (16 USC Section 1451 et. seq.) requires the development and implementation of programs to manage the land and water resources of the coastal zone, including ecological, cultural, historic, and aesthetic values. States must implement programs in conformity with EPA guidance. Remedial actions that impact the coastal zone are subject to 15 *CFR* Part 923—Coastal Zone Management Program Regulations. 15 *CFR* Part 923 administered by the National Oceanic and Atmospheric Administration (NOAA)—provides the criteria for approving state programs.

Texas' approved Coastal Management Program administered by the TCCC is recorded at 31 *TAC* Chapter 501. Specific criteria in this program include policies for development in critical areas as described above. Section 501.23(a) (7) states development in critical areas shall not be authorized if significant degradation will occur. Significant degradation occurs if an activity: threatens an endangered or threatened species or its habitat; violates any applicable surface water quality standards; violates a toxic effluent standard; adversely effects human health and welfare (including effects on fish, shellfish, wildlife, and the consumption of fish and wildlife); adversely effects aquatic ecosystems; or adversely effects generally accepted recreational aesthetics or economic value of the critical area.

A.3.4 <u>Floodplains</u>

As described in Section 1.0, the Site is located within the 100-year coastal floodplain. As such, remedial alternatives involving on-site treatment, storage or disposal facilities for RCRA hazardous waste at the Site are subject to the 40 CFR 264.18(b) requirements that they be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by the 100-year flood. Per 40 CFR 6.302(b), Executive Order 11988 requires that any actions performed within the floodplain avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of the floodplain.

A.4 ACTION-SPECIFIC ARARs

Action-specific ARARs are divided into the following sections:

A.4.1 RCRA Unit-Specific Standards
A.4.2 Air Emissions
A.4.3 Effluent Discharge
A.4.4 Landfill Cap Construction

A.4.1 <u>RCRA Unit-Specific Standards</u>

If hydraulic control of affected groundwater is provided by a groundwater extraction and treatment system, the treatment system may be treating a hazardous waste (i.e., the contaminated groundwater may be characteristically hazardous due to concentrations of certain contaminants such as tetrachloroethene). Thus, the unit-specific RCRA design and operating standards for units that treat hazardous waste must be considered. In addition, several air emission standards must be considered.

Under RCRA, there are several exemptions from the unit-specific management standards for units that treat hazardous waste (40 *CFR* 264.1(g)). One of these units is a wastewater treatment unit. A wastewater treatment unit is defined in 40 CFR 260.10 as, "a device which: (1) is part of a wastewater treatment facility that is subject to regulation under either Section 402 or 307(b) of the Clean Water Act; (2) receives and treats or stores an influent wastewater that is a hazardous waste…; and (3) meets the definition of a tank or tank system."

The groundwater treatment system would meet all three criteria of a wastewater treatment unit and, thus, would not be subject to the unit-specific design and operating standards under RCRA. First, if the groundwater treatment system discharge to the City of Freeport POTW through an industrial discharge permit, the system would be subject to regulation under the Clean Water Act (i.e., through the industrial pre-treatment discharge limitations established by the POTW). Second, the groundwater treatment system would be treating an influent hazardous wastewater if the groundwater were classified as a hazardous waste due to the toxicity characteristic for one or more contaminants. Lastly, the treatment system would meet the definition of a tank in 40 CFR 260.10: "a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials (e.g., wood, concrete, steel, plastic) which provide structural support."

A.4.2 Air Emissions

The groundwater treatment system would use an air stripper to remove volatile organic chemicals (VOCs) from the groundwater. Air emissions will be generated by the treatment system that may be subject to several Federal and state air quality regulations. Specifically, the following regulations were considered for their applicability and are discussed in detail below:

- New Source Performance Standards (NSPS) (40 *CFR* Part 60);
- National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 *CFR* Parts 61 and 63);
- RCRA Air Emissions Requirements (40 *CFR* Part 264, Subparts AA, BB, and CC/30 *TAC* 335.152(a)(17) and (18));
- Control of Air Pollution from Volatile Organic Compounds (30 *TAC* Chapter 115); and
- Permits by Rule – Waste Processes and Remediation (30 *TAC* Chapter 106, Subchapter X).

Federal Clean Air Act regulations for NSPS and NESHAPs would not apply to a groundwater treatment system because it is not one of the regulated unit types in the NSPS or NESHAP rules. Likewise, RCRA-specific air emissions requirements will not apply due to the wastewater treatment unit exemption as described above. Texas state air emission standards, however, may potentially apply as ARARs.

There are two sections in 30 *TAC* Chapter 115 that could apply to the groundwater treatment system, including §§115.112 through 115.119, which regulate VOC emissions from storage vessels and §§115.121 through 115.129, which regulate VOC emissions from vents. The groundwater treatment system, however, is likely exempt from the control and monitoring requirements of these regulations due to the relatively small size of the equipment and anticipated low emission rates (based on groundwater extraction/treatment flow rate and VOC concentrations in groundwater). Specifically, storage tanks with less than 1,000 gallons capacity are exempt from control requirements under §115.112(c)(1), Table I(b) and vent gas streams having a combined weight of VOCs less than or equal to 100 pounds in any continuous 24-hour period are exempt from control requirements of §115.121(a)(1), (see §115.127(a)(2)(A)).

State Permits By Rule regulations for remediation processes that could apply to the groundwater treatment system are provided in 30 TAC §106.533. This section describes the emissions rate limits (in lbs/hour) by compound that are required to qualify for permit by rule eligibility and specifies the performance requirements for emissions control devices under a permit by rule.

A.4.3 Effluent Discharge

The effluent from a groundwater extraction and treatment system would be discharged to the City of Freeport POTW. The City's industrial discharge rates and ordinances would apply to this discharge. As such an industrial wastewater discharge permit is required by the City as discharge limits, monitoring and reporting would be subject to City standards described in Chapter 51 of the City of Freeport Code of Ordinances (Freeport, 2009).

A.4.4 Landfill Cap Construction

The former surface impoundments were closed under a Texas Water Commission (TWC)-approved plan in 1982. Ongoing operation/maintenance of the existing cap constructed as part of this closure is included in Alternatives 2 and 3. Although not directly applicable to the Class I industrial solid waste unit designation under which the former surface impoundments were closed, the 30 TAC §330.457 requirements for municipal solid waste landfill units may potentially be considered relevant and appropriate to the existing cap, specifically the §330.457(3)(b) requirement that Class I industrial solid waste "be covered with a four-foot layer of compacted clay-rich soil", which is identified as having a coefficient of permeability no greater than 1×10^{-7} cm/sec. The TWC-approved closure plan implemented in 1982 provided for a clay thickness of three feet. Soil borings drilled through the cap during the RI indicated clay thicknesses ranging from 2.5 feet to over 3.5 feet. Maintenance activities to be implemented as part of the O&M plan to be developed for the cap will add another 0.5 feet of clay to the cap, thus assuring a cap thickness of at least 3.0 feet and, in some instances, more than 4.0 feet. As detailed in the RI Report, laboratory-measured hydraulic conductivities for the existing cap material ranged from 5.0 x 10^{-9} cm/sec to 3.5 x 10^{-8} cm/sec. These values are approximately one-third or less of the 1 x 10^{-7} cm/sec value specified in §330.457(3)(b), thus indicating that the three-foot thickness of the existing cap can be considered functionally equivalent to a four-feet thick cap constructed of clay with 1 x 10^{-7} cm/sec hydraulic conductivity.